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Han

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(54) **MANUAL DIE SET FOR PRESSING
EXPLOSIVE POWDER INTO HARDWARE**

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(*) **Notice:** Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(57) **ABSTRACT**

A manual die set includes a ram, the ram having an upper
portion and a lower portion; a ram head removably con-
nected to the upper portion of the ram; a die, the die defining
an opening therethrough for reciprocally receiving the ram,
the die including a top portion and a bottom portion, the
bottom portion including an upward facing step; a support
ring disposed in the die opening in the bottom portion of the
die, the support ring defining a bore therethrough; a base-
plate disposed in a bottom of the die opening and extending
into a bottom of the support ring bore; a die guide plate for
supporting the die and the baseplate; and a spring disposed
in the die opening, the lower portion of the ram being
inserted through a center of the spring, a lower end of the
spring bearing against the upward facing step in the bottom
portion of the die, an upper end of the spring bearing against
a bottom face of the upper portion of the ram; wherein the
spring is compressed when a pressing force moves the ram
downwardly such that when the pressing force is removed
from the ram, the spring forces the ram to move upwardly.

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(52) **U.S. Cl.:** **86/30; 86/23; 86/29; 86/30**

(58) **Field of Search** **89/47, 24; 86/30;
86/29, 36, 23, 43**

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12 Claims, 2 Drawing Sheets

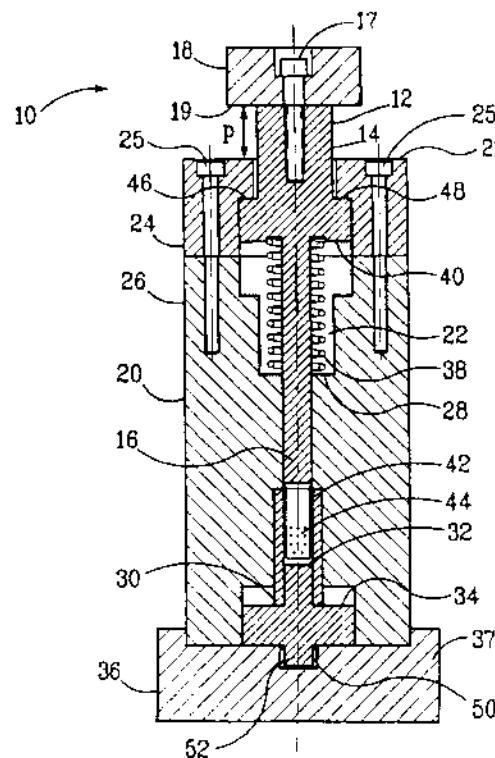


FIG. 4

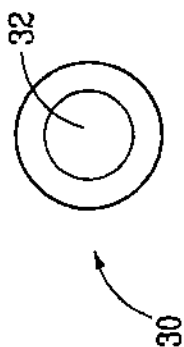


FIG. 5A

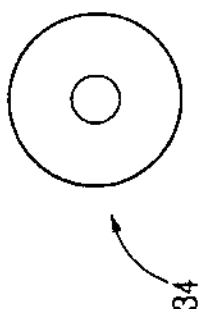


FIG. 5B

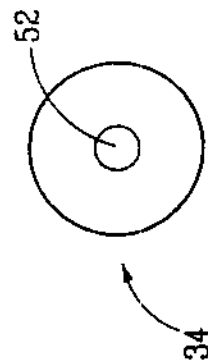


FIG. 6

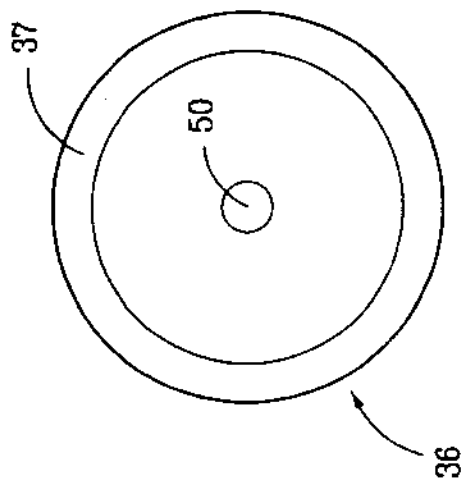


FIG. 7A

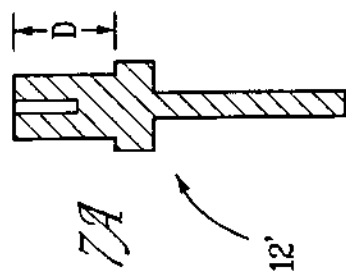
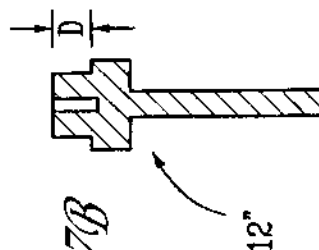


FIG. 7B



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FIG. 5(A) is a top view of the baseplate.

FIG. 5(B) is a bottom view of the baseplate.

FIG. 6 is a top view of the die guide plate.

FIGS. 7(A) and 7(B) are cross-sectional elevation views of interchangeable rams.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is a manual die set and process for pressing highly sensitive explosive powder into hardware, such as a cup. Because the ram of the invention is not fixed to a press, there is no need to manufacture tooling for attaching the ram to the press. In addition, there is no need to align a fixed ram and die. Also, the press may be used for other operations by simply removing the manual die set from the press. Another advantage of the present invention is that variations in the amount of explosive powder used, which require different ram travel lengths, may be accommodated by simply substituting one part of the die set.

FIG. 1 is a cross-sectional elevation view of one embodiment of a manual die set 10 according to the invention. FIG. 2(A) is a reduced cross-sectional elevation view of the top portion 24 of the die 20. FIG. 2(B) is a reduced cross-sectional elevation view of the bottom portion 26 of the die 20. FIG. 3 is a reduced cross-sectional elevation view of the ram 12 and ram head 18.

Manual die set 10 includes a ram 12 having an upper portion 14 and a lower portion 16. A ram head 18 is removably connected to the upper portion 14 of the ram by, for example, a cap screw 17. A die 20 defines an opening 22 therethrough for reciprocally receiving the ram 12. Die 20 includes a top portion 24 and a bottom portion 26. The top portion 24 of the die 20 is removably connected to the bottom portion 26 of the die 20 by, for example, cap screws 25. The bottom portion 26 of the die 20 includes an upward facing step 28.

A support ring 30 is disposed in the die opening 22 in the bottom portion 26 of the die 20. The support ring 30 defines a bore 32 therethrough. FIG. 4 is a top view of the support ring 30. A baseplate 34 is disposed in a bottom of the die opening 22 and extends into a bottom of the support ring bore 32. A die guide plate 36 supports the die 20 and the baseplate 34. FIG. 5(A) is a top view of the baseplate 34. FIG. 5(B) is a bottom view of the baseplate 34. FIG. 6 is a top view of the die guide plate 36. The ram 12, ram head 18, die 20, support ring 30, baseplate 34 and die guide plate 36 are all made of hardened tool steel.

A spring 38 made of, for example, steel or a steel alloy, is disposed in the die opening 22. The lower portion 16 of the ram 12 is inserted through a center of the spring 38. A lower end of the spring 38 bears against the upward facing step 28 in the bottom portion 26 of the die 20. An upper end of the spring 38 bears against a bottom face 40 of the upper portion 14 of the ram 12. Spring 38 is compressed when a pressing force moves the ram 12 downwardly such that when the pressing force is removed from the ram 12, the spring 38 forces the ram 12 to move upwardly to its retracted position.

Spring 38 is compressed even when the ram 12 is fully retracted. The free length of spring 38 is about 0.25 inches longer than its length when the ram 12 is fully retracted. The spring constant of spring 38 is, for example, 300 pounds/inch. The pressing force is applied to ram head 18 by, for example, a conventional hydraulic press in the 100 to 200 ton range. The force applied is in the range of about 15 kpsi to 30 kpsi.

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A cup 42 has explosive molding powder 44 disposed therein. The cup 42 is disposed in the support ring bore 32 between the lower portion 16 of the ram 12 and the baseplate 34. The cup 42 is supported by the baseplate 34.

The upper portion 14 of the ram 12 includes an upward facing step 46. The top portion 24 of the die 20 includes a downward facing step 48 that limits upward movement of the ram 12 by engaging the upward facing step 46 of the upper portion 14 of the ram 12. A pressing distance P is defined by a distance between a bottom surface 19 of the ram head 18 and a top surface 21 of the die 20, when the ram 12 is in a fully retracted position, as in FIG. 1.

The manual die set 10 further includes a plurality of interchangeable rams. FIGS. 7(A) and 7(B) are cross-sectional elevation views of interchangeable rams 12' and 12". A distance D from the upward facing step of the upper portion of each ram 12', 12" to a top surface of the upper portion of each ram varies from ram to ram so that the pressing distance P is adjustable by changing rams in the manual die set 10. Although two rams 12', 12" are shown, it should be understood that additional rams having varying distances D may be used in the manual die set 10. The rams are changed by removing ram head 18 from ram 12. Cap screws 25 are removed and the top portion 24 of the die 20 is lifted off of bottom portion 26. Ram 12 is then lifted out of die opening 22 and a different ram is inserted through spring 38 in die opening 22. The top portion 24 of die 20 is replaced and ram head 18 is attached to the new ram.

The die guide plate 36 includes a circumferential shoulder 37 on a top surface thereof. The bottom of die 20 is disposed within the confines of circumferential shoulder 37. The die guide plate 36 also includes a circular opening 50 in a center of the top surface. The baseplate 34 includes a cylindrical extension 52 on a bottom surface thereof. The baseplate cylindrical extension 52 is disposed in the circular opening 50 of the die guide plate 36 for alignment purposes.

The manual die set 10 operates in the following manner. The cup 42 is filled with the desired amount of explosive molding powder 44, for example, PBXN-9 or PBXW-11. Cup 42 is placed in support ring bore 32 and baseplate 34 is inserted below cup 42. Cup 42, support ring 30 and baseplate 34 are inserted in the bottom of die opening 22. Die 20 is placed on die guide plate 36 and baseplate cylindrical extension 52 is inserted in circular opening 50 in the die guide plate 36. The manual die set 10 is then placed in a conventional press (not shown). The press may be operated remotely from a safe distance through a conventional remote control.

The press applies force to the ram head 18, which forces the ram 12 downwardly to compress the explosive powder 44 into a pellet in cup 42. After a required dwell time, the pressing force is released from the ram head 18. The spring 38 then forces the ram 12 upward to its retracted position. Die 20 is lifted off die guide plate 36 and baseplate 34 is removed. Support ring 30 and cup 42 with the explosive pellet therein are removed as a unit. Support ring 30 and cup 42 are then inserted into a known crimping device to close the top opening in cup 42. The procedure is then repeated.

Different sizes of manual die set 10 may be used, depending on the diameter of cup 42. Some exemplary dimensions of one preferred embodiment are as follows (all dimensions are in inches): cup 42 inside diameter, 0.380; cup 42 outside diameter, 0.475; support ring 30 inside diameter, 0.4075; support ring 30 outside diameter, 0.6500; support ring 30 vertical height, 1.510; die opening 22 inside diameter at support ring location, 0.6510; die opening 22 inside diam-